

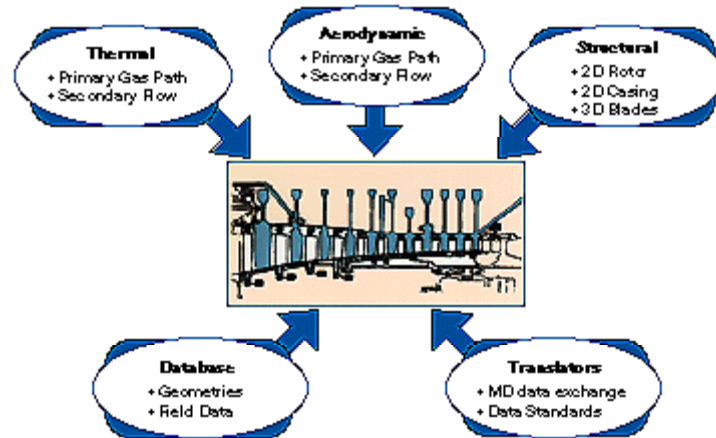
# **Coupled Aerodynamic-Thermal-Structural (CATS) Analysis**

Coupled Aerodynamic-Thermal-Structural (CATS) Analysis is a focused effort within the Numerical Propulsion System Simulation (NPSS) program to streamline multidisciplinary analysis of aeropropulsion components and assemblies. Multidisciplinary analysis of axial-flow compressor performance has been selected for the initial focus of this project. CATS will permit more accurate compressor system analysis by enabling users to include thermal and mechanical effects as an integral part of the aerodynamic analysis of the compressor primary flowpath. Thus, critical details, such as the variation of blade tip clearances and the deformation of the flowpath geometry, can be more accurately modeled and included in the aerodynamic analyses. The benefits of this coupled analysis capability are (1) performance and stall line predictions are improved by the inclusion of tip clearances and hot geometries, (2) design alternatives can be readily analyzed, and (3) higher fidelity analysis by researchers in various disciplines is possible. The goals for this project are a 10-percent improvement in stall margin predictions and a 2:1 speed-up in multidisciplinary analysis times.

Working cooperatively with Pratt & Whitney, the Lewis CATS team defined the engineering processes and identified the software products necessary for streamlining these processes. The basic approach is to integrate the aerodynamic, thermal, and structural computational analyses by using data management and Non-Uniform Rational B-Splines (NURBS) based data mapping. Five software products have been defined for this task: (1) a primary flowpath data mapper, (2) a two-dimensional data mapper, (3) a database interface, (4) a blade structural pre- and post- processor, and (5) a computational fluid dynamics code for aerothermal analysis of the drum rotor.

Thus far (1) a cooperative agreement has been established with Pratt & Whitney, (2) a Primary Flowpath Data Mapper has been prototyped and delivered to General Electric Aircraft Engines and Pratt & Whitney for evaluation, (3) a collaborative effort has been initiated with the National Institute of Standards and Testing to develop a Standard Data Access Interface, and (4) a blade tip clearance capability has been implemented into the Structural Airfoil Blade Engineering Routine (SABER) program.

### CATS System Components



*CATS system components.*

We plan to continue to develop the data mappers and data management tools. As progress is made, additional efforts will be made to apply these tools to propulsion system applications.